126. The process of claim 125 wherein the liquid phase flows on the surface of the interior wall, the liquid phase being in the form of a thin film.

127. The process of claim 124 wherein part of the wicking region forms a wall for the open area of the process microchannel.

128. The process of claim 127 wherein the liquid phase flows in the wicking region and the vapor phase flows in the open area of the process microchannel and contacts at least part of the liquid phase in the wicking region.

129. The process of claim 121 wherein each microchannel distillation section comprises a liquid region, a vapor region positioned above the liquid region, and a bubble cap tray positioned above the vapor region.

130. The process of claim 121 wherein each microchannel distillation section comprises a tray, the tray comprising a capture structure for collecting liquid and an opening for permitting the flow of the vapor phase through the tray.

131. The process of claim 123 wherein the process microchannel has an internal dimension of width or height of up to about 10 mm.

132. The process of claim 123 wherein the process microchannel has an internal dimension of width or height of up to about 2 mm.

133. The process of claim 123 wherein the process microchannel is made of a material comprising: steel; monel; inconel; aluminum; titanium; nickel; copper; brass; an alloy of any of the foregoing metals; a polymer; ceramics; glass; a composite comprising a polymer and fiberglass; quartz; silicon; or a combination of two or more thereof.

134. The process of claim 123 wherein the heat exchanger comprises at least one heat exchange channel having an internal dimension of width or height of up to about 10 mm.

135. The process of claim 123 wherein the heat exchanger comprises at least one heat exchange channel having an internal dimension of width or height of up to about 2 mm.

136. The process of claim 123 wherein the heat exchanger comprises at least one heat exchange channel, the heat exchange channel being made of a material comprising: steel; monel; inconel; aluminum; titanium; nickel; copper; brass; an alloy of any of the foregoing metals; a polymer; ceramics; glass; a composite comprising polymer and fiberglass; quartz; silicon; or a combination of two or more thereof.

137. The process of claim 125 wherein the capture structure comprises wire mesh.

138. The process of claim 125 wherein the capture structure comprises one or more inverted cones, liquid-nonwetting porous structures, liquid-wetting porous structures, perforated foils, fibers, or a combination of two or more thereof.

139. The process of claim 124 wherein the wicking region comprises a wick.

140. The process of claim 139 wherein the wick comprises one or more sintered metals, metal screens, metal foams, polymer fibers, or a combination of two or more thereof.

141. The process of claim 124 wherein the wicking region comprises a wicking surface.

142. The process of claim 141 wherein the wicking surface comprises grooves in one or more interior walls of the process microchannel.

143. The process of claim 142 wherein the grooves are aligned parallel to the direction of flow of the vapor phase in the process microchannel.

144. The process of claim 142 wherein the grooves are aligned tangentially to the direction of flow of the vapor phase in the process microchannel.

145. The process of claim 142 wherein the grooves provide a flow path for the liquid phase to flow between microchannel distillation sections.

146. The process of claim 142 wherein the grooves are etched into at least one wall of the process microchannel using a laser.

147. The process of claim 124 wherein the wicking region comprises a wire mesh that is welded to at least one wall of the process microchannel.

148. The process of claim 121 wherein the flow to the liquid phase is driven by gravitational forces.

149. The process of claim 121 wherein the flow of the liquid phase is driven by gravitational force and/or a pressure differential.

150. The process of claim 121 wherein the fluid mixture comprises ethane and ethylene.

151. The process of claim 121 wherein the fluid mixture comprises styrene and ethylbenzene.

152. The process of claim 121 wherein the fluid mixture comprises oxygen and nitrogen.

153. The process of claim 121 wherein the fluid mixture comprises cycohexane and cyclohexanol or cyclohexanone.

154. The process of claim 121 wherein the fluid mixture comprises hexane and cyclohexane.

155. The process of claim 121 wherein the fluid mixture comprises isobutane.

156. The process of claim 121 wherein the fluid mixture comprises naptha.

157. The process of claim 123 wherein an endothermic or exothermic process is conducted in the heat exchange channel.

158. The process of claim 157 wherein the exothermic process comprises a water-gas shift reaction, a methanol synthesis reaction or an ammonia synthesis reaction.

159. The process of claim 157 wherein the endothermic reaction comprises a steam reforming process or a dehydrogenation process.

160. The process of claim 123 wherein a heat exchange fluid is in the heat exchange channel.

161. The process of claim 160 wherein the heat exchange fluid undergoes a phase change in the heat exchange channel.

162. The process of claim 160 wherein the heat exchange fluid undergoes partial boiling in the heat exchange channel.

163. The process of claim 121 wherein the microchannel distillation sections have heat exchange channel zones thermally communicating with the microchannel distillation sections, a heat exchange fluid flows in the heat exchange channel zones, the heat exchange fluid undergoes partial boiling in the heat exchange channel zones, the pressure of the heat exchange fluid in each of the heat exchange channel zones being different.

164. The process of claim 121 wherein the microchannel distillation sections have heat exchange channel zones thermally communicating with the microchannel distillation sections, a heat exchange fluid flows in the heat exchange channel zones, the heat exchange fluid undergoes partial